

analyses of a 25 month University of Washington study, E5, and reports additional findings of tumors not reported in the peer-reviewed article: benign pheochromocytoma of the adrenal medula ( $p < 0.023$ , one tailed), malignant tumors at all sites ( $p < 0.0012$ ), carcinomas at all sites ( $p < 0.018$ ) and glandular carcinoma for combined glands ( $p < 0.018$ ). ( $p < x$  means the likelihood of seeing this difference or more is less than  $x$ ).

6. Epidemiology studies that pertain to RF exposure and cancer outcomes are referenced in Table 5.5 of E192 and are presumed to be those studies where frequency is reported as other than "probably mostly 0.00006 MHz" (i.e. 60 Hz).. Most of these studies have been reviewed by the Ad-Hoc Association above in the discussion of E191 or in the ex parte comments of the Ad-Hoc Association dated June 10, 1997, page 29-38. Of interest is the study by Robinette, Silverman, and Jablon, 1980, item 9.10 on page 34 of the June 10, 1997 ex parte comments just noted. The Ad-Hoc Association noted that among those persons studied in the 'high exposure' group, those estimated to have the highest exposure had statistically significant highest mortality rates [at item 9.10, pg. 35 of the June 10, 1997 just noted comments]. This finding is also noted in E192, Table 5.5.11, as well as in E201, Table 3-15, pages 132 and 142.

Also please see Appendix 2, 3, and 4 of E192. These provide opinions and experiences of many researchers where past studies are noted that give cause for concern, and were they to be replicated, then there would be strong indications for more stringent limits. Here are also noted needed further research - this also demonstrates there are remain many important unknowns. Appendix 5, provides an important review of microwave - cancer research studies by the FDA, as discussed above, this FDA review concludes,

*"The fact remains, however, that the data which exists strongly suggests that microwaves can, under at least some conditions, accelerate the development of malignant tumors. This in vivo data is also supported by in vitro data which has demonstrated not only malignant transformation but other effects on the cell's growth control mechanisms."* [Appendix 5 of E192].

For details and comments on most of the epidemiology studies given in Table 5.5 of E192 and also on other related studies on people noted elsewhere by the Ad-Hoc Association please see

the following exhibits: E36, E39, E49, E59, E80, E87, E89, E91, E92, E97, E98, E99, E100-E108, E124-E127, E130-E131, E142-E144, E151-E152, E164, E178, E180, E188, E198, E199, E200, as well as other exhibits.

**E193** provides a brief introduction to RF signal considerations, prepared by the Office of Technology Assessment.

**E194** Photograph of a personal wireless services facility located on a roof at 5601 Rainier Avenue South, Seattle, WA 98118. See Permit #688433 for "install panel antenna on roof" to be owned by the GTE telecommunications company [see Exhibit #E204 enclosed]. The photograph shows a view of the transmitter taken from the porch of a nearby home; the photo shows the porch is about the same height as the transmitter. This demonstrates, that while it may not make 'engineering sense' to place a transmitter so low that nearby homes are as high as the transmitter, that this is done nevertheless - probably due to a willing lessor. Since cities often put height limits on transmitters on monopoles, this photo demonstrates that just as convenience rather than engineering concerns led to a low height transmitter on a roof, so too can the same be expected for transmitters on monopoles which are over 10 meters high. Thus, the photo suggests that due to convenience such monopole transmitters may be constructed even if there are nearby tall buildings which partially block or attenuate the signal. For such tall buildings, the present Commission rules in 47 CFR §1.1307 do not require an evaluation of a cellular phone or Personal Communications Services (PCS) transmitter on a monopole if it is over 10 meters high - regardless of how close may be nearby tall buildings, and as shown in the Ad-Hoc Association FCC 96-326 Petition [at page 5,6 in item 7] that out-of-compliance conditions may thus occur and not be detected because the rules in 47 CFR §1.1310 would not require an evaluation of exposure for such conditions.

**E195.** Report by Dr. Cletus Kanavy, the Chief of the biological effects group of the Phillips Laboratory's Electromagnetic Effects Division at Kirtland Air Force, NM in October, 1992. The report indicates that there is evidence of non-thermal effects of RF that have impacts on "behavioral aberrations, neural network perturbations, fetal (embryonic) tissue damage (inducing birth defect), cataractogenesis, altered blood chemistry, metabolic changes, and suppression of the

endocrine and immune systems," and including occupational studies showing functional changes at levels ranging from "fractions of microwatts."

E196. A progress report by Wireless Technology Research, L.L.C (previously the SAG as in E192 above). Of particular interest is its progress report on DNA damage observed at levels below the 4 W/kg hazard threshold from which the Commission's exposure limits are derived. Specifically, E196 reports on studies by Sarkar et al. (1994) see Exhibit E3, which were done at 1.18 W/kg (30% of the 4 W/kg hazard threshold of the Commission) and report a statistically significant rearrangement of the DNA of mice, where E3 states, *"It is interesting to note that in a large number of bands at the identical positions in DNA of both the control and the exposed groups of animals, rearrangement of DNA is observed consistently in all the exposed animals in the same region..."* [E3: pg. 143, 144]

E196 also reports on a study by Lai and Singh (1995) [in Ad-Hoc Association FCC 96-326 petition at pg. 16 and footnote 132 therein, also see paper at E19] in which an RF induced increase in DNA single strand breaks occurred at 0.6 W/kg, 15% of the Commissions hazard threshold, and determined using an assay called the Single Cell Gel (SCG) assay. WTR established the Single Cell Gel (SCG) Expert Panel to advise it concerning this assay. E196 reports this panel met in October 1994 and reported that,

*"The SCG assay, due to its sensitivity, to be an appropriate assay for the assessment of potential effects of RFR on DNA structure."* [E196, page 23]

The progress report also acknowledged there was evidence, although what it called minimal, of RF causing genotoxic effects, and the report stated,

*"given that there is minimal evidence of RFR related non-thermal genotoxic effects, tumor promotion must be considered as a possible mechanism of action."* [E196, pg. 25]

Moreover, let the Commission recall that the Ad-Hoc Association ex parte comments #3, dated July 7, 1997 provided evidence that also at 1.2 W/kg, Lai et al. (1996) and paper E20, found both single and double strand DNA breaks using the SCG assay, and reports, such breaks can cause cancer, cell death, damage to cells and "could be a cause of accelerated ageing and

neurodegenerative disorders, and *"has been associated with Alzheimer's disease, Huntington's disease, and Parkinson's disease."* [E20, pg. 518-519]

Also, recall that in the above July 7, 1997 ex parte submission, a pre-publication paper by Lai et Singh (1997). reported evidence that at 1.2 W/kg exposure that there was an increase in free radicals [see pg. 5, footnote 3 and associated article in the above July 7, 1997 submission].

Therefore, the acknowledgment by the WTR that there is evidence of non-thermal genotoxic effects at 15% to 30% of the hazard threshold of the Commission is further strengthened by the new results reported after the July 1995 publishing of E196.

**E197** This exhibit contains 2 chapters, 17 and 23 from Modern Bioelectricity, 1988. Chapter 17, by R. Medici, on Behavioral Measures of Electromagnetic Field Effects both reviews studies showing disruption of behavior at low levels of exposure. It also explains that some studies have not found such disruption because they were not designed to detect effects at low exposure levels. Therefore, the Commission and those federal health agencies reviewing and evaluating this material can better understand and reconcile seemingly contradictory results. As shown, the results are not contradictory, since those finding 'negative' results did not exactly replicate studies of 'positive' effects, and were not designed to detect such effects. Herein the author notes such researchers as J. Thomas did use sensitive and correct methods [see papers of this author in Ad-Hoc Association FCC 96-326 Petition at pg. 10, 11 (footnote 84, 85, 88) ], and thus strengthens the evidence submitted by the Ad-Hoc Association. Chapter 23, by Allan Frey , provides an historical perspective on RF research at low levels, cites many studies showing effects at low exposure levels, and discusses why other studies seemingly have not replicated results due to design or analysis problems, and thus the results did not truly contradict those showing low level effects.

**E198:** A report by Don Justeson,(1989) on recent developments on protection guides for RF radiation in the United States provides support for the Ad-Hoc Association claims that the Commission's limits are not sufficiently protective. The author was a member of IEEE Subcommittee IV on Safety Levels with Respect to Human Exposure, 3 kHz to 300 GHz, of IEEE Coordinating Committee 28 at the time IEEE C95.1-1991 was prepared. Also, he was one

of 6 member of the National Council of Radiation and Protection (NCRP) committee which recommended RF exposure criteria in 1986, and referenced in FCC 96-326.

Regarding "Burns and Shocks" he states that persons familiar with the power density and electric field strength of the ANSI RF standard C95.1-1982 "should be prepared to see some downward revision of limit, especially those at the lower end of the spectrum." [page 218 of E198]. He explicitly notes a lesson, which it is presumed he verified, of an EPA researcher, Richard Tell, who *"learned by direct experience when climbing highly powered low-frequency antennas. The lesson is that electric shocks and RF burns can be induced in the human body at relatively low power densities."* [page 218 of E198]. This public acknowledgment of presumed verified shock and/or burn of Dr. Tell also raises questions about the statement in the IEEE C95.1-1991 standard now in effect for Commission licensed Personal Communication Services base station transmitters. This standard states,

*"No verified reports exist of injury to human beings or of adverse effects on the health of human beings who have been exposed to electromagnetic fields within the limits of frequency and SAR specified by previous ANSI standards, including ANSI C95.1-1982."* [Section 6: Rationale, IEEE C95.1-1991].

Since the Commission's present and to be implemented new limits for Occupational / Controlled environments do not change the power density or electric field strength of the ANSI C95.1-1982 standard, and since the Commission has refused to require the elements of an RF health and safety program as recommended by OSHA, it is unclear on what basis the Commission determines its limits should provide sufficient protection. Indeed, the evidence suggests otherwise, and supports the claims and requests of the Ad-Hoc Association FCC 96-326 petition.

In addition, E198 reviews the studies of Szmigielski et al. (1982) [see E137] and Chou et al. (1992) [see E5, E6] noted above [and in the Ad-Hoc Association FCC 96-326 Petition at 14.3.8 and 14.3.9- page 11 and footnote 89, and in item 12 19.3 page 16 (footnote 111), and in the Ad-Hoc Association ex parte comments dated June 10, 1997, pages 25-27, in footnote 23, 40, 41, and elsewhere]. He then states,

*"There are data that have created justifiable concern that the 4 W/kg threshold of harm may need to be revised downward. Reference is first to the studies of mice in Poland by Szmigielski and colleagues (and refers to the above Szmigielski et al. 1982 paper) in which three different stages of experimental malignancies were promoted - not induced - by long term, but intermittent, microwave irradiation at SARs near 2 W/kg. Second, I refer to the celebrated, but yet-to-be-archival report of experiments on rats by Prof. Arthur W. Guy and colleagues at the University of Washington. These experiments, which subjected animals to near life-long exposures to microwaves, revealed that SARs circa 0.4 W/kg were associated with a reliable increase of malignancies above control incidence. Remarkably, despite a nearly fourfold greater incidence of malignant tumors in exposed animals as compared with controls, average life spans did not differ. These data and those from the study performed in Poland have not been independently confirmed. The putative threshold of hazardous irradiation would doubtless be driven lower if either set of malignancy data met the critical scientific test of confirmation. It is ironic, to say the least, that levels of funding of research of microwaves and other high-frequency RF radiations have decreased so dramatically that attempts to confirm the malignancy studies may never be undertaken. The dilemma for participants in the standard-setting process is obvious: One should not use unconfirmed findings; but one is justifiably uneasy when well-executed experiments generate a portent of malignant disease."* [page 218]

The Commission should note some important points:

1. D. Justesen finds the Szmigielski studies "well executed, " generating "justifiable concern," and generating a "portent of malignant disease." Thus, he appears to disagree with the evaluation of this study given in E192 that "the conclusion of the authors that RFR may be recognized as a carcinogenic risk factor is not supported by the data presented." [E192, pg. 100] Rather in agreement with the FDA and in agreement with the IEEE C95.1-1991 committees that found the paper suitable for use in standard setting and meriting being among the Final List of Papers Reviewed For IEEE C95.1-1991. Moreover, since the Commission has established a policy of acting "out of an abundance of caution," [FCC 96-326, para. 92], it should view the

Szmigielski paper as a well designed, executed, and analyzed experiment, lacking only the "confirmation" that D. Justesen notes is lacking in order to justify more stringent limits.

2. Note that the study by Chou et al. is found by Justesen "to reveal a reliable increase of malignancies" and he makes **no** suggestion that the finding is "of doubtful biological significance" [E192, page 102], but rather implies that all that is lacking is confirmation before more stringent limits are justified.

3. D. Justesen notes "one is justifiably uneasy" with the 4 W/kg hazard threshold which the Commission has adopted given the above studies. This uncertainty clearly supports the claim of the Ad-Hoc Association that the Commission cannot claim its limits should be sufficiently protective, and it justifies the Commission requiring that exposures shall be kept as low as reasonably achievable.

4. Also note the view of D. Justesen that further confirmation is needed is needed before setting limits is not in agreement with some experts at the 1993 EPA RF conference described in Exhibit E17, and referenced by the Ad-Hoc Association FCC 96-326 petition at footnote 70 therein. There it is noted "several panelists" felt that "overall there must be more willingness to accept certain publications, even though, because of reasons such as constrained funding, the results might not have had what might be considered by some to be adequate replication; any ensuing uncertainty resulting from such an approach can be incorporated into the standard." [Panel 6, page 35 therein].

5. Also note that D. Justesen does not review the paper by Szudzinski et al (1982) [see discussion in E192, paper by Szudzinsk et al (1982) included in the FDA review in Appendix 5 of E192, and submitted as an exhibit with the Ad-Hoc Association FCC 96-326 petition, and the full paper in E7, and discussed in the Ad-Hoc Association ex parte comments of June 10, 1997 at pg 25,26 as item 7.4 and as footnote 41 therein.] E192 pg. 100-101 correctly reports that this Szudzinski et al. (1982) paper uses "*the same initiation/co-carcinogenesis model*" and "*reports essentially the same findings as reported by Szmigielski et al. (1982).*" Accordingly, since D. Justesen found the Szmigielski et al. 1982 study "well executed," (with 40 mice per group), this would suggest he would approve of the design and analysis of the Szudzinski et al. (1982) study

(with 100 animals per group) were he to have evaluated it. Thus, the "confirmation" he sought has been published, with both articles being peer-reviewed and in different journals [Szmigielski et al (1982) in Bioelectromagnetics, and Szudzinski et al. (1982) in the Archives of Dermatological Research]; however, since 5 of the 6 co-authors of Szudzinski et al. (1982) were co-authors of Szmigielski et al (1982) the 'total' independence of research is not what some may require - but given the policy of the Commission to act "*out of an abundance of caution*" [FCC 96-326, para. 92], it would seem prudent to act as if the Szudzinski et al. (1982) were a sufficiently independent replication. Moreover, since the D. Justesen review published in 1989 other animal studies have found a consistent association of RF and cancer when exposure was near or below the Commission's hazard threshold and when the exposure period was at least as long as in the Szmigielski et al (1982) study for effects to be apparent - 4 months as reported by the FDA in Appendix 5 of E192. See discussion on pages 25-29 of the Ad-Hoc Association ex parte comments dated June 10, 1997 in which 3 of 3 additional studies of at least 4 months duration find a biological effect of microwaves on cancer development at levels below the Commission hazard threshold. 2 of these found a promotion effect; these are Repacholi et al. 1997, see item 7.1, and Toler, 1997 item 7.2 (based on data reported in Microwave News March/April 1997 and not based on the author's own conclusions or analysis - the Commission is encouraged to have the federal health agencies evaluate the analysis provided in that ex parte presentation.). One analysis by W.R.Adey reported results for which an independent analysis showed a statistically significant suppressive effect on brain tumor development [item 7.9 discussed on pages 27-29 of the June 10, 1997 ex parte submission of the Ad Hoc Association. Possible causes for this suppressive effect were noted in a subsequent submission. Namely, in the June 30, 1997 ex parte submission of the Ad-Hoc Association findings were reported showing that at 0.08 W/kg, 1/50th of the Commission's hazard threshold, there were decreases in the rate of cells expelling a by product of cell decay, putrescine [item 2.1.2 therein]; it was also reported that at levels as low as 50 microwatts per sq. cm. there are certain receptors in the brain sensitive to RF stimulation [item 2.4(i), and that these brain receptors when stimulated can initiate nitrous oxide (NO) synthesis, and NO is a free radical. Thus, the apparent suppressive effect noted by Adey may be due to NO



free radicals killing cancer cells or increased putrescine killing the cancer cells. Thus, the observed suppressive effect indicates a biological action which while killing or suppressing malignant growth, may also have adverse effects on healthy nerve cells.

Hence, all three of the above recent long term animal studies indicate a portent of adverse effects below the Commission's hazard threshold, and thus strengthen the indication of D. Justesen that given the evidence, *"one is justifiably uneasy when well-executed experiments generate a portent of malignant disease."* [E198, pg. 218].

E199: In 1987 H. Lai and D. Justesen prepared a review of biological responses to RF fields for the City of Seattle. They indicate, "The contents of the 20 reports are focused on health effects, especially those involving malignancies." [1-A-4 (24) therein]. The Commission and those with RF health effects expertise who on behalf of the Commission are evaluating health effects comments of the Ad-Hoc Association are encouraged to read this report, and so the 20 studies evaluated there will not be reviewed here. However, some highlights should be noted. These are:

1. Studies tend to show a commonality of outcome:

"authors of several studies report a heightened incidence of malignancies in workers exposed to RF fields," and while there may be some disagreements in the results, "The disagreements dilute but do not dismiss the cogency of submitting the hypothesis (increased cancer risk) to experimental test."

2. The common outcome was a positive association between RF and cancer:

"The second question addressed in this review is whether the in vivo and in vitro experimental findings are supportive of a hypothesized connection between RF irradiation and malignant disease. The answer is a highly qualified yes."

3. Using rats or mice, even inbred especially susceptible mice, is an arguably reasonable test for human toxicity, especially for sensitive individuals - from this perspective the findings positive association found for rodents is relevant for humans.

"The thrust of these rules [mandated by the U.S. Food and Drug Administration( FDA)] is that an agent producing toxicity in laboratory animals has prima facie weight as a human toxin. Admittedly more of a legislated than a scientific principle, one may nonetheless offer supportive scientific argument. The life spans of man and mouse indeed may differ, but the latter species ostensibly has greater resistance to acute insult by microwave fields at the intensities and doses used by Szmigielski and colleagues [E137] And the charge that a genetically susceptible strain of animal fails to emulate the human condition is valid only for healthy human beings free of individuals that share with inbred mice a heightened sensitivity to insult. These individuals too are deserving of protection." [1-A-4 (40) to (41) in E199]

4. Regarding the study by Chou et al [paper in E5, discussed above in E192 and elsewhere noted above] Lai and Justesen note [in 1-A-4 (40) to (42) in E199] that:

4.1 The lack of an association between life span and RF effects may be due to most deaths being from causes other than cancer so that, "If the cancer datum is real, and if the SARs were close to threshold values, somewhat higher SARs would have been needed to induce a the (sic) higher incidence of malignancies that would be reflected in truncated survival."

4.2 Unjustified dismissal of Kunz et al (later published in a peer-reviewed journal as Chou et al [in E5] )

"As noted, the finding of a high percentage of primary malignancies in the rats of Kuntz et al (later published in an archival journal as Chou et al. [in E5] ) has been dismissed by some scientists as a quirk of chance. This dismissal is predicated on the differing sites of tumor growth and kinds of tumors, and because the historical data on the normal, untreated Holtzman rats used by Kunz et al. indicate that a high incidence of malignancies is common in the aging animal. The first criticism is valid for a carcinogen or co-carcinogen with a specific affinity for some organ, but it may not hold for an agent that results in non-specific stress. The second criticism is of little merit because historical data cannot control for the vagaries of a particular experimental environment."

5. To prevent shock and burn, the current U.S. exposure standards are too high

*"Based solely on established thresholds of burn and electric-shock hazards, currently permissible thresholds to electric fields in the United States are more than 35 times too high at certain frequencies."* [page 1-A-4 (44) in E199]. This further supports the evidence given in item 4.6, 4.6.1 to 4.6.10 of the June 10, 1997 ex parte comments of the Ad-Hoc Association, which is that since the Commission has determined measurement of contact current cannot be reliably measured that, therefore, to provide reasonable protection it should lower electric field strengths and power densities to prevent such shock and burn for touching objects which typically are found in the human environment, as was researched by O.P. Gandhi [noted in item 4.6.9, and footnote 78 in the just noted June 10, 1997 ex parte comments and provided to the Commission as E140 in the ex parte comments of July 14, 1997, and E140B in the ex parte comments of July 24, 1997, discussed in the Ad-Hoc FCC 96-326 Petition at footnote 66, in E180 in ex parte comments dated July 24, 1997, and in E202 in ex parte comments dated July 31, 1997 - all submitted by the Ad-Hoc Association.

For example, consider Exhibit E140, which was referenced as B26 in the RF standard IEEE C95.1-1991 adopted by the Commission for Personal Communication Services base stations, and which therein stated that E140 provided "An anatomically realistic model of a human being" There it states,

"Since higher E-fields proposed in Table 1 for the band 0.003 - 1000 MHz, if these were vertical, would result in high RF induced body currents and a potential for shock and burns for contact with ungrounded metallic bodies, the personnel access areas should be limited in the following manner..." [page 110 of E140, E140B, by O.P. Gandhi]. For example, for 62.5 MHz, the recommended electric field is 8 Volts per meter (which is equivalent to  $8^2/3.77 = 17$  microwatts per sq. cm.), and results, when considering touching an ungrounded car, van or school bus, etc., of a maximum of 7.8 W/kg in the ankle of a 5 year old child. Note that 62.5 MHz is the frequency now used for channel #3 (60 to 66 MHz) and is near that for channel 2 (54-60 MHz) and for channel 4 (66 to 72 MHz) [given in E201, pg. 501, where E201 was submitted with ex parte comments dated July 31, 1997 by the Ad-Hoc Association.]. This exposure was chosen since the RF standard ANSI C95.1-1982 called for a maximum local body Specific Absorption

Rate (SAR) of RF energy to be no more than 8 W/kg in any 1 gram of tissue, which is the maximum SAR for local body exposure

The Commission's maximum allowed local body exposure for the ankles is 4 W/kg for the General population/uncontrolled environment. While this limit now only applies to mobile transmitters, the Ad-Hoc Association requested the Commission extend the principal of limits on local body SAR to base station transmitters as provided for in both the EPA recommended 1986 RF standard of the National Council for Radiation Protection and Measurement (NCRP) [see reference in 47 CFR §1.1310 Note To Introductory Paragraph and see NCRP 1986, section 17.4.5] and was a principal also provided for in the RF standard IEEE C95.1-1991, section 4.2 and 6.2. [see item 28, on pages 75-78 of the Ad-Hoc Association dated June 30, 1997].

Therefore, to protect 5 year old children from exceeding 4 W/kg in the ankles, the maximum exposure should be 9 microwatts per sq. cm [= 17 microwatts per sq. cm. x (4/7.8)]. However, the Commission's new limits in 47 CFR §1.1310 allows for this signal (of 62.5 MHz) an exposure of 200 microwatts per sq. cm, 22 fold greater than appropriate for reasonable assurance that the 4 W/kg localized SAR will not be exceeded.

6. "Independent confirmation of the studies of Szmigielski et al 1982 [in E137] and especially, of the study of Kunz et al (Chou et al. 1992 in E5) would augur the need for a new operational definition of the SAR threshold of harm in U.S. standards for limiting exposures to RF fields. [page 1-A-4 (43) in E199]

7. Positive findings of roughly similar but not identical studies is a kind of 'confirmation'

I is a scientific truism that no datum is hard datum that establishes a reasonable claim to a causal linkage until confirmed in independent experiment. by this criterion, if strictly interpreted, all the in vivo studies under review present soft data in need of confirmation. If more generously interpreted, one can make a case that the findings of Kunz [later became Chou et al. 1992 in E5] and colleagues represent an extension if not confirmation of the findings of Szmigielski and colleagues [in E137]. [and it is noted above that Szudinski et al (1982) [in E7] is a replication

confirming Szmigielski et al 1982 [in E137], and other recent studies have also found adverse effects including cancer promotion [see above point #5 for E198 discussion].

Therefore, since the Commission has chosen a policy of acting "out of an abundance of caution" [FCC 96-326, para. 92, it should treat 'confirmation' as "more generously interpreted" as described above. Then the needed confirmation would be found to justify more protective limits, and if not, then at least the Commission needs to refrain from claiming believe its limits are sufficient to protect the public and worker health, but rather acknowledge that there is evidence for other effects which should make one feel "justifiably uneasy" [as described by D. Justesen in E198 above] and justifies the Commission requiring that RF exposures from its licensees shall be kept as low as reasonably achievable.

**E200** Chapter 7 from the book *The Microwave Debate* (1984) focus on the issue of Science, Scientists, and Science Policy. Some highlights indicate that to ascertain properly evaluate studies and assure of correct and complete information, that the Commission must be very thorough and assure input and evaluations from many different parties with different roles and interests concerning RF bioeffects. This can be seen from some of the following comments from E200.

1. *"The scientific community has allowed social, economic, and political pressures to influence its activities, thereby destroying credibility of its product."* [E200, page 176]

2. N. Stenick notes that a plan to study RF effects on rats exposed for 25 months [in E6] neglected to mention behavioral measures even though at the time of the study it was well accepted that behavioral measures were the most sensitive indicators of RF bioeffects. Moreover, when concern was raised about this, the behavior chosen was a measure of random activity in an open field [in E5], and not a measure of 'behavior disruption' of a learned task which was considered the most sensitive measure and was used for standard setting for ANSI C95.1-1982. While some defended this choice due to a study by a Russian researcher, N.Steneck notes that in the referenced 1979 study<sup>4</sup> researchers *"tested animals on a more intense time schedule and discovered as well that effects tended to disappear during long-term exposure."* [E200 page 169 and footnote 64 on page 259]. Thus, it appears that in the study plan that the measure found to be most sensitive to RF was to be ignored by the long-term study, and then upon a raising of

concern ,it appears that the behavior method selected for the long term study was one already found by others to show only effects for short term acute exposure and to show no effects during a long-term, as in the 25 month study. It is also curious, that if indeed this study did provide a reliable and sensitive measure, then it is unclear why this 1979 study<sup>4</sup> was not included in the papers found suitable for standard setting when ANSI C95.1-1982 was developed, being absent from the list of references or bibliographical list provided in the Appendix of this standard.

3. On Blood-Brain-Barrier leakage, which the RF1986 NCRP report states that under some conditions could result in *"increased intracranial pressure, and in irreversible damage to the brain."* [1986 NCRP, section 10.3.1, page 121-122].

3.1 "In addition it was not at all certain how short-term experiments related to long term exposure....Such doubts notwithstanding, the blood-brain barrier controversy was soon speculated away." [E200, page 173]

3.2 Concerning a report summarizing a 1978 Navy workshop on blood-brain barrier leakage, "The state of scientific knowledge was correctly assessed as incomplete. The report then went on to draw a second conclusion: 'There appears to be no theocratical or experimental evidence that low-level microwaves that do not raise the brain temperature could be expected to affect the integrity of the barrier.' This second conclusion was the untested and also misleading one. Despite claims to the contrary [Allan] Frey's work had not been replicated by other researchers. It was not true, as the final report claimed citing a 1977 publication, that 'Oscar and Hawkins were unable to replicate Frey's results'."

Moreover, Steneck reported that in the original draft summary of the workshop summary it stated,

"Department of Defense funding of research evaluating the effect of microwaves on the blood-brain barrier should be of low priority. This was the justification used to curtail barrier research in the years to come. This open announcement of policy broke with establishment tradition, however. Most planning in the military is done in closed meetings, and the results are not usually publicized. The break with tradition was quickly recognized by one of those reviewing the conference for the military, who wrote in the margin of the draft version of the

workshop summary, 'do we really want to say this?' Apparently they did not: the third conclusion [this one] was omitted when the final report was submitted in May 1979." [E200, page 174].

4. *"Policy deliberations too have been hampered by the politization of RF bioeffects research and by the biases and inconsistencies discussed earlier,"* [E200, pg. 175]; some examples are shown below.

Additional comments on federal health agency evaluations:

N.Steneck, in Chapter 9, not provided in the exhibits, reports on "Hearings and Litigation: The Last Resort." There he describes a hearing in which the U.S. Environmental Protection Agency (EPA) was asked to review the adequacy of an Environmental Impact Statement (EIS) concerning a telecommunications project in the State of Washington, 1982<sup>6</sup>. Steneck reports, that the U.S. EPA had gone on record on May 12, 1982, as supporting the accuracy and objectivity of the EIS, with EPA stating,

*"The calculations regarding microwave radiation in the Draft EIS appear to be accurate and EPA agrees with the conclusion that, on the basis of the available health effects information in the literature, the exposure levels caused by the RCA earth station will not result in any adverse health impact on humans."*<sup>7</sup> [page 214 of footnote 5]

In addition, Steneck reports that also in May 1982 a request was made to the EPA under the Freedom of Information Act asking for the documents it had used to formulate its response to the EIS. Steneck reports,

*"The documentation released to support EPA's position consisted of two letters. The first, as short letter from the chief of the surveillance branch, Rick Tell, raised minor concerns about the calculated power levels.<sup>8</sup> The second, a longer letter from the director of the Experimental Biology Division, Joe Elder, carefully documented a few of the many obvious biases contained in the EIS. Elder's final conclusion, which hardly supported EPA's public position, was that 'the authors did a poor job of reviewing and citing the literature and reveal a lack of scientific insight into the complexities of the biological effects of microwave radiation.'"*<sup>8</sup> [footnote 5, page 214]

While it is hoped that the above presumable misunderstanding between persons within the EPA was an unusual, and hopefully unique occurrence, yet such presumably misunderstood communications indicate that the Commission follow with due diligence and caution its proper and correct policy and decision that the Commission *"is not a health and safety agency and would defer to the judgment of these expert agencies [e.g. the federal agencies with responsibility with oversight regarding RF health and safety issues] with respect to determining the appropriate levels of safe exposure to RF energy. We continue to believe that we must place special emphasis on the recommendations and comments of Federal health and safety agencies because of their expertise and their responsibilities with regard to health and safety matters."* [FCC 96-326, para. 28] The Commission can practice such due diligence by obtaining from the federal health agencies not only their summary conclusions, but also detailed comments, and references providing all of the documents, memos, reports, and other documentation that was developed to prepare any summary evaluation. Moreover, since the Ad-Hoc Association FCC 96-326 petition has made a number of specific claims and requests, the Commission should ask the each claim and request be separately evaluated in depth and with specificity.

**E201** Is yet another review of the RF biological effects literature. It is provided for several reasons which are:

1. It is among the most recent reviews, having been published in 1995, and therefore may contain studies, not noted in other reviews submitted by the Ad-Hoc Association.

2. It includes some important papers, or comments on some papers which other reviews do not mention. For example:

- 2.1 It is the only review found which documents a study of how metal rimmed eyeglass spectacles may act as antenna attracting RF signals and reflecting into the eye, thereby increasing exposure, see Exhibit E95 for the paper, submitted with ex parte comments of July 14, 1997.

- 2.2 It is one of the few reviews that cites statistically significant increases in hematopoietic progenitor cells in a follow-up study Exhibit E183 under the same conditions as in exhibit E5 [see Ad-Hoc Association June 30, 1997 ex parte comments item 7.2.3 and footnote therein 130, noted in E201 at page 117 as Chou et al. 1985]



2.3 It is also one of the few reviews that cites an epidemiological study finding decreased fertility among occupationally exposed workers (military personnel) [see Weyandt, 1992 pg. 138 in E201, and full report in E152.

2.4 It is also one of the few reports found which correctly reports increased total mortality and increased respiratory cancer in a study of U.S. Navy personnel serving in the Korean War [noted in the comments dated June 10, 1997 of Ad-Hoc Association, at item 9.10, at page 34-35, and noted in E201 at page 132, Robinette et al. 1980, and in E201 at page 142]

### 3. Some key studies were missing:

It also illustrates that some key study are not covered in some typical reviews, such as E201. For example, 2 papers finding behavioral disruption of behavior at levels below the Commission's 4 W/kg hazard threshold were identified as among the 120 papers in the Final List of Papers Reviewed For IEEE C95.1-1991, listed in Appendix B of IEEE C95.1-1991 [see Exhibit E161], yet neither of these papers are reviewed in E201, even though they are noted in the Ad-Hoc Association Fcc96-326 petition as Thomas et al. 1982 on page 10 and at footnote 84 therein [see paper at E35], and Thomas et al. 1979 on page 11 and at footnote 88 therein]

### 4. Hypothesized or anticipated differences are sometimes portrayed as 'inconsistencies'

Sanders et al. 1984 [see E29] noted that the mitochondria of nerve cells in the brain contain iron and copper ions which are part of certain proteins, and hypothesized that "The presence of specific molecular interactions would be supported by a frequency specificity of the effects because one cannot predict such a frequency specificity based on the macroscopic dielectric properties of biological systems." [E29 at page 420]. They reasoned that if RF caused certain proteins to oscillate or otherwise be disturbed, then this would interfere with brain metabolism, and a consequent change in ATP (adenosine triphosphate) - the chemical 'fuel' of the brain. Then they designed an experiment using different frequencies and anticipating finding frequency specific effects on ATP concentration or utilization. Results of the experiment found decreased amounts of ATP at 200 MHz and at 591 MHz, but no changes at 2450 MHz. The authors then noted past observations that,

"RF induced dipole oscillations in proteins in solution are found in the 30 to 1000 MHz frequency range." [E29, page 432].

They then hypothesized that there were no effects at 2450 MHz because this is frequency was beyond the range at which the affected proteins were found to oscillate.

Thus, the researchers concluded their data was consistent with past observations of the frequency range at which the proteins have been known to be affected by certain frequency ranges.

Nevertheless, when E201 reviewed this study, it was only stated,

*"The authors hypothesized that the observed effects are not thermal and that RF fields directly inhibit mitochondrial energy production pathways. However, the results were not consistent across the three frequencies."* [E201, page 75].

It is unclear why the review of this study ended as above. One would have expected something like,

*"The authors hypothesized that the observed effects are not thermal and that RF fields directly inhibit mitochondrial energy production pathways. with certain frequencies having different impact on the protein molecules which include electrically charged iron or copper ions based on past studies showing such frequency effects. The authors noted the results were consistent with past studies showing that frequencies over 1000 MHz do not have impacts that found among those between 30 and 1000 MHz."*

Yet, by phrasing the results as "However,...." may give the impression to some readers that the results are inconsistent with current theory or past observations, where in fact the opposite is so. It is unclear why the reviewers of E201 chose the language style for summarizing the results which the researchers did find consistent with past history and the science of charged proteins.

Also, it is of interest to note that concerning reporting disruption of operant behavior (disruption of a learned behavior or learning of a new behavior) that the authors report, regarding a study by Schrot, Thomas, and Banvard, 1980 [at E201, page 85] that for doses of 0.7 W/kg and 1.7 W/kg that, "Significant differences in response to acquisition task at higher dose rate." It is of

interest that to some readers it may be unclear as to whether or not at the lower dose rate of 0.7 W/kg there was an adverse effect on learning a new task; this is important since present RF standard setting criteria is based upon the threshold of disruption of operant behavior. The authors of the actual study [at E50] report "At 5 mW/cm<sup>2</sup> (0.7 W/kg) error responding was increased during most of the session, with only a few periods of errorless sequence completion" [see E50 pg. 92, 95] - thus even at the lower value of 0.7 W/kg there was a significant disruption of operant behavior -and this was noted in the Petition at item 14.3.5 on page 11, footnote 85 therein].

It is unclear why for the two above examples the intended findings of the authors appeared not to be as clearly specified as some may find helpful.

#### 5. Conclusions appear not to summarize results

"The reviewers state, even well-established thermal effects may appear to be equivocal when experiments are performed near the threshold of effects." [E201 page 187] However, they do not state what they find that threshold to be. Since disruption of learned behavior continues to be the criteria used for standard setting, one might expect that a conclusion might at least be made concerning this criteria.

For example, the reviewers note, "D'Andrea and colleagues, 1986b [see paper in exhibit E78] observed the threshold for effects between 0.14 W/kg and 0.7 W/kg for male rats chronically exposed to CW (continuous wave), 2450 (MHz ) MWs (microwaves), although the effects were more clearly established at the higher SAR." [E201, pg. 92, and referenced in the Petition at pg. 16 footnote 133]. Also, as noted above and in the Ad-Hoc Petition, a study by Schrot et al. 1980 also found effects at 0.7 W/kg. Therefore, since 0.7 W/kg was found by two independent research groups, it is unclear why in the conclusion, these results were not noted, since they pertain to the criteria upon which present standards are based and are about 18% of the presently designated hazard threshold of 4 W/kg.

In addition to these two studies there are other studies in this review with disruption of behavior as well as other biological effects found at below 4 W/kg. The Commission should ask

those reviewing this submission to evaluate these studies and their impact on setting exposure limits.

The Ad-Hoc Association is concerned that because the existing standards has selected 4 W/kg as a hazard threshold, that reviews of disruption of behavior are reluctant to make a finding that may contradict that of present standards, even when reviewed studies suggest a lowering of the threshold has support. At least one might expect a discussion of why a reviewer believes a lower threshold is not supported, even in spite of the existence of studies that suggest otherwise.

Conclusion: Therefore, the above considerations support the Ad-Hoc Association claims that the Commission cannot state that its exposure criteria are known to be sufficiently protective of the health of workers and the public. Rather it should state as shown above, e.g. that there is evidence of modulation specific effects and of frequency specific effects, and that the research unit of the telecommunications industry itself acknowledges that frequencies and modulation schemes of the new technology have not been evaluated. Accordingly, the Commission cannot say its limits will be protective, but state that research organizations are concerned there may be effects of the new technology which have not been evaluated. This also supports the Ad-Hoc Association request that RF exposure from Commission licensed facilities "shall be as low as reasonably achievable."

**Footnotes:**

**A. Comments on Exhibits:**

Notation:

Exhibits below were submitted with the 5 th ex parte submission unless otherwise stated. These exhibits primarily pertain to references given in footnotes in previous submissions or otherwise support claims and requests of the Ad-Hoc Association FCC 96-326 and FCC 96-487 petitions. All exhibits should be presumed protected by copyright unless published by a public agency.

**Footnotes describing exhibits submitted ex parte and dated July 14, by exhibit number:**

**NOTICE: All of the following material may be protected by copyright law (Title 17 U.S. Code)**

**Exhibits that were not numbered as Exxx when submitted:**

Submitted with Ad-Hoc Association Petition for Reconsideration of FCC 96-326

**Exhibit 1:** Subscriptions to the Petition for Reconsideration

**Exhibit 2:** Some members of the Ad-Hoc Association

**Exhibit 3 -** Test Measurement Protocol of Carrol Cobbs and his biographical profile

**Exhibit 4 -** Balloting Information for the ballot to adopt IEEE C95.1-1991, who voted, how, and association, plus reasons for negative votes

**Exhibit 5:** A paper from the Final List of Papers Reviewed For IEEE C95.1-1991 by V.S. Belokrinskiy, "Destructive and Reparative Processes in Hippocampus with Long Term Exposure to Nonionizing Radiation," in U.S.S.R. Report, Effects of Nonionizing Electromagnetic Radiation, No. 7, JPRS 81865, pp. 15-20

**Exhibit 6:**

Policy statement from the New Zealand Ministry of Education on no longer signing leases for telecommunication facilities, dated 21 March 1996

California Public Utilities Commission recommendation not to site wireless telecommunications facilities near schools or hospitals, dated Nov. 8, 1995

Newspaper article documenting how personal wireless service transmitters are being placed at low heights, Seattle Times

Notice in the Los Angeles Times on LA Cellular apologizing for non-compliance, April 16, 1995, LA Times pg. A14

News item in Microwave News of March/April 1993 pg. 10, indicating the penalties LA Cellular must pay.

Excerpts from ANSI Z136.1-1993 pg. 31,34 and -1996 pf. 28. These show that the allowed IEEE C95.1-1991 limits are expected to likely be uncomfortable to view and feel upon the skin, and gives the power density for partial body exposures which are less than IEEE C95.1-1991.

Examples of 2 engineering reports for transmitters filed in the City of Seattle, WA. These show that predicted maximum exposure from a single cellular phone facility can be 10% of the Commissions exposure limits.

Letter from E.Ramona Travato of EPA, dated Mar. 1, 1995 to H.Patrick Wong, stating, "EPA has not conducted any study which concluded there is a level at which there cannot be any non-thermal effects, nor are we aware of any peer-reviewed study which reach that conclusion." not aware of

**Exhibit 7:**

FDA report on the status of microwaves and cancer. The report is found in Appendix 5 of Exhibit E192 below.

Bioelectromagnetic Society 18th Annual Meeting Abstracts, A-7-3 showing study of W.R. Adey suggested RF conditions had a suppressive affect on brain tumor growth, e.g. a biological effect at levels below the hazard threshold of the Commission.

Article, "Supprising results in 1st Cellular Phone Animal Study: Digital Signals Appear To Protect Against Brain Tumors," Microwave News, May/June 1996

**Exhibit 8:**

J.D. Dumasnkij and M.G. Sandala, "The Biological Action and Hygenic Significance Of Electromagnetic Fields of Superhigh and Ultrahigh Frequencies in Densely Populated Areas," from Biological Effects and Health Hazards of Microwave Radiation, Proceedings of an International Syposium, Warsaw 15-18 October, 1973, Polish Medical Publishers, Warsaw, 1974

Letter from epidemiologist Samuel Milham Jr. M.D. to Norman Smith, Department of Health, State of Washington, April 7, 1992, advising that RF exposure should be kept as low as reasonably achievable.

**Exhibit 9:**

"EMI to Medical Devices from Cellular Antennas," Microwave News May/June 1996

Cover of the pleading of the group "Hear It Now" before the FCC seeking exposure conditions that would not cause hearing aid interference, dated June 5, 1995, submitted by Baker & Hostetler, Washington, DC. (202) 861-1500

EMC Considerations For Digital Cellular Radio and Hearing Aids, by Jon Short, BT Laboratories, Martlesham Heath, Ipswich, England. Presented as part of the European COST 219 research activity.

Documents included with the ex parte submission dated July 7, 1997 and submitted in accordance with 47 CFR §1.1200 to §1.1216

- H.Lai and N. Singh, "Melatonin and a Spin-Trap Compound Block Radiofrequency Electromagnetic Radiation-Induced DNA Breaks in Rat Brain Cells," Bioelectromagnetics - in press. Effect occurred at 1.2 W/kg.

- A.M.Phelan et al, (1992) "Modification of Membrane Fluidity in Melanin-Containing Cells by Low-Level Microwave Radiation," Bioelectromagnetics 13: pg. 131-146
- I.Y. Belyaev et al (1992), "Resonance Effect of Microwaves on the Genome Conformal State of E. coli Cells," Z.Naturforsch. Vol 47c, pg. 621-627
- I.Y.Belyaev (1992), "Some biophysical aspects of the genetic effect of low-intensity millimeter waves," Bioelectrochemistry and Bioenergetics, Vol 27, pg. 11-18
- Vera Garaj\_Vrhovac et al (1990), "Comparison of chromosome aberration and micronucleus induction in human lymphocytes after occupational exposure to vinyl chloride monomer and microwave radiation," Periodicum Biologorum, Vol. 92, No. 4, page 411-416
- "FDA Workshop on Biological Effects of Wireless Radiation: Politics and Lack of Research Funds Stymie Progress," Microwave News March/April 1997
- C.K.Chou et al (1985), "Specific Absorption Rate in Rats Exposed to 2450 MHz Microwaves Under Seven Exposure Conditions," Bioelectromagnetics, Vol. 6, pg. 73-88

The following exhibits were submitted as ex parte submissions and submitted in accordance with 47 CFR §1.1200 to §1.1216

- o For the ex parte submission dated: July 9, 1997, the following exhibits were included: E86, E93, and E101 to E104
- o For the ex parte submission dated: July 14, 1997, the following exhibits were included: E1 to E85, E87 to E92, E94 to E100, and E105 to E166
- o For the ex parte submission dated: July 24, 1997, the following exhibits were included: E140B, E167 to E187
- o For ex parte submission dated: July 31, 1997, the following exhibits were included: E188 to E203]
- o For ex parte submission dated: August 21, 1997, the following exhibit is included: E204

### **List of Exhibits**

This list may be used while reading the Ad-Hoc Association FCC 96-326 Petition or any other Ad-Hoc Association submitted document. Many of the references and footnotes given in this submission are listed below, and may be studies either (1) to verify claims about the article, or (2) to read for additional information which would support the claims and requests of the Ad-

Hoc Association or other parties in this proceeding indicating concern that the Commission's limits may not be sufficiently protective of the public health and worker health.

- E1.** Report of the Nonionizing Electric and Magnetic Fields Subcommittee of the U.S. Environmental Protection Agency Scientific Advisory Board's Radiation Advisory Committee, report # EPA-SAB-RAC-92-013, January 29, 1992, pages 1-7, and Appendix B-1 to B4.
- E2.** B. Veyret et al., 1991, "Antibody responses of mice exposed to low-power microwaves under pulse- and amplitude modulation," *Bioelectromagnetics*, 12:47-56.
- E3.** S. Sarkar et al, 1994, "Effect of low power microwave on the mouse genome: A direct DNA analysis," *Mutation Research*, Vol: 320, pg. 141-147.
- E4.** M. Anver et al., 1982, "Age-Associated Lesions in Barrier-Reared Male Sprague-Dawley Rats: A Comparison Between Hap: (SD) and Crl:COBS<sup>®</sup> CD<sup>®</sup> (SD) Stocks," *Experimental Aging Research*, Vol. 8, No. 1.
- E5.** C.K. Chou, A.W. Guy et al, 1992, "Long Term, Low-Level Microwave Irradiation of Rats," *Bioelectromagnetics* 13:469-496.
- E6.** A. Guy et al., January 1980, "Study of Effects of Long-Term Low-Level RF Exposure on Rats: A Plan," *Proceedings of the IEEE*, Vol. 68, No. 1.
- E7.** Szudzinski et al., 1982, "Acceleration of the Development of Benzopyrene-Induced Skin Cancer in Mice by Microwave Radiation," *Archives of Dermatological Research*, Vol. 274: 303-312. [see EP1: footnote 41]
- E8.** Salford, L, (1993) "Experimental Studies of brain tumor development during exposure to continuous and pulsed 915 MHz radio frequency radiation," in *Bioelectrochemistry and Bioenergetics*, Vol. 30: pg. 313-318. [see P: footnote 128, which is corrected here, and see EP1: footnote 43]
- E9.** T.A. Litovitz et al, 1993, "The Role of Coherence Time in the Effect of Microwaves on Ornithine Decarboxylase (ODC) Activity," *Bioelectromagnetics*, Vol. 14:pg 395-403 (1993) Shows ODC increases at 2.5 W/kg, and similar to effects as direct ELF power line fields. [see P: footnote 43].
- E10.** R. Wu, 1994, "Effects of 2.45-GHz Microwave Radiation and Phorbol Ester 12-O-Tetradecanoylphorbol-13-Acetate on Dimethylhydrazine-Induced Colon Cancer in Mice," *Bioelectromagnetics* Vol 15, pg. 531-538, 1994.
- E11.** M. Rice et al., "Study of Electromagnetic Interference (EMI) Between Portable Cellular Phones and Medical Equipment," Institute of Biomedical Engineering, University of Toronto and Department of Medical Engineering, The Hospital for Sick Children, Toronto, Canada. Shows using data from Exhibit #37, at what low power density EMI has occurred. [no copyright]
- E12.** D. McRee, "Soviet and Eastern European Research on Biological Effects of Microwave Radiation," *Proceedings of the IEEE*, Vol. 68, No. 1, January 1980.
- E13.** A.R. Sanders et al, 1984, "The Effects of Hyperthermia and Hyperthermia Plus Microwaves on Rat Brain Energy Metabolism," *Bioelectromagnetics*, Vol. 5: 63-70.
- E14.** O.P. Gandhi, 1988, "The ANSI Radiofrequency Safety Guidelines: Its Rationale and Some Problems," in *Biological Effects of Electropollution: Brain Tumors and Experimental Models*, ed. S. K.Dutta and R.M.Millis, published and copyright by Information Ventures, Inc., Philadelphia, PA.
- E15.** Lai, H, et al, 1994, "Microwave Irradiation Affects Radial-Arm Maze Performance in the Rat," *Bioelectromagnetics*: 15:95-104, [P: fn 131]
- E16.** Assorted collection of abstracts of scientific papers.



- E17.** "Summary and Results of the April 26-27, 1993 Radiofrequency Radiation Conference, Vol. 1. Analysis of Panel Discussions, U.S. Environmental Protection Agency, March 1995, #402-R -95-009. [P:fn 70].
- E18.** S. Forman, C. Holmes, T. McManamon, and W. Wedding, "Psychological Symptoms and Intermittent Hypertension Following Acute Microwave Exposure," *Journal of Occupational Medicine*, Vol. 24, No. 11, November 1982, pg. 932-934. S. Forman is a physician who is a lieutenant commander at the Naval Regional Medical Center in Long Beach, California; C. Holmes and T. McManamon are both physicians and commander and captain respectively at the San Diego, California Naval Regional Medical Center; W. Wedding is a lieutenant commander at the Department of Radiology, San Diego, California Naval Regional Medical Center. [EP2,fn 64]
- E19.** Lai, H. et al, 1995, "Acute Low-Intensity Microwave Exposure Increases DNA Single-Strand Breaks in Rat Brain Cells, in *Bioelectromagnetics* 16: 207-210, [in P:fn 132]
- E20.** Lai, H. et al. 1996, "Single and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation," *International Journal of Radiation Biology*, Vol. 69, No. 4, pg. 513-521.
- E21.** K. Oscar et al., "Microwave Alteration of the Blood-Brain Barrier System in Rats," *Brain Research*, 126, pp. 281-193, 1977 [P: fn 59].
- E22.** K. Oscar et al, 1981, "Local cerebral blood flow after microwave exposure," *Brain Research*, Vol. 204, pg. 220-225.
- E23.** M.Battalora, et al., 1995, "The effects of calcium antagonists on anthrone skin tumor promotion and promoter-related effects in SENCAR mice," *Cancer Letters*, Vol. 98, pg. 19-25. [EP2: fn 212]
- E24.** S. Takashima, 1979, "Effects of Modulated RF Energy on the EEG of Mammalian Brains," *Radiation and Environmental Biophysics*, Vol. 16, pg. 15-27
- E25.** Kues, H, et al. (1985) Effects of 2.45 GHz microwaves on primate corneal endothelium," *Bioelectromagnetics*, Vol 6: 177-188. [P: fn 78]
- E26.** W. Bise, 1978, "Low Power Radio-Frequency and Microwave Effects On Human Electroencephalogram and Behavior," *Physiological Chemistry and Physics*, Vol. 10, No.5, 387-398.
- E27.** A.P. Sanders et al., 1980, "Microwave Effects on Energy Metabolism of Rat Brain," *Bioelectromagnetics*, Vol. 1: pg. 171-181.
- E28.** A. Sanders et al, 1985, "Effects of continuous-wave, pulsed, and sinusoidal amplitude-modulated microwaves on brain energy metabolism," *Bioelectromagnetics* 6:89-97 [EP2: fn12]
- E29.** A. Sanders et al, 1984, "The differential effects of 200, 591, and 2450 MHz radiation on rat brain energy metabolism," *Bioelectromagnetics* 5: 419-433. [EP2: fn 11]
- E30.** H.Lai, A.Guy et al, 1989, "Low-Level Microwave Irradiation and Central Cholinergic Systems," *Pharmacology Biochemistry and Behavior*, Vol. 33, pp. 131-138
- E31.** H. Lai, A.Guy et al, "Opioid Receptor Subtypes That Mediate a Microwave-Induced Decrease in Central Cholinergic Activity in the Rat," *Bioelectromagnetics*, Vol. 13, pg. 237-246.
- E32.** R.P.Liburdy et al, 1984, "Radiofrequency radiation and the immune system. Part 3. In vitro effects on human immunoglobulin and on murine T- and B- lymphocytes," *International Journal of Biology*, Vol. 46, No. 1, pg. 67-81.
- E33.** H.Kues, 1992, "Increased Sensitivity of the Non-Human Primate Eye to Microwave Radiation Following Ophthalmic Drug Pretreatment," *Bioelectromagnetics*, Vol. 13, pg. 379-393
- E34.** V.V.Vorobyov, 1997, "Effects of Weak Microwave Fields Amplitude Modulated at ELF on EEG of Symetric Brain Areas in Rats," *Bioelectromagnetics*, Vol. 18, pg. 293-298